

Original Research Article

Diagnostic Accuracy of Magnetic Resonance Imaging in Prediction of Soft Tissue Carcinoma, Taking Histopathology as Gold Standard

Article History:

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Abstract:

Objective: The rationale of this study is to determine the accuracy of MRI in diagnosing soft tissue carcinoma, by taking histopathology as reference standard.

Study type: Cross-sectional (validation) study.

Settings: Department of Radiology Fauji Foundation Hospital, Rawalpindi.

Duration: 20th May 2025 to 19th October 2025.

Methodology: Total 80 patients who presented with suspected soft tissue cancer (soft tissue swelling accompanied by fever, malaise, or body aches lasting longer than two weeks) were included. Patients taking chemotherapy for any type of lesions, liver cirrhosis, claustrophobic patients and with cardiac pacemakers were excluded. Next, a 3.0 T MRI machine was used for magnetic resonance imaging. Axial and coronal T1WI and axial and sagittal fat-suppressed T2WI were among the traditional MRI procedures. The consultant radiologist assessed the MRI results for soft tissue carcinoma based on the following criteria: intermediate signal intensity on T1-weighted, high signal intensity on T2-weighted MRI, and peripheral enhancement. Following a biopsy, the histopathology report and the MRI results were compared for each patient.

Results: 41 patients (True Positive) had soft tissue cancer out of those who tested positive for it on MRI, whereas 07 patients (False Positive) had no soft tissue carcinoma according to histopathological results. 32 patients who had negative MRI results, 4 (False Negative) developed soft tissue cancer on histology, while 28 (True Negative) did not ($p=0.0001$). Soft tissue cancer was diagnosed with MRI sensitivity of 91.11%, specificity of 80.0%, PPV of 85.42 %, NPV of 87.50%, and diagnostic accuracy of 86.25%.

Conclusion: According to the study's findings, MRI is an extremely sensitive and precise imaging technique for diagnosis of soft tissue carcinoma.

Keywords: soft tissue carcinoma, magnetic resonance imaging, sensitivity.

INTRODUCTION

Lesions known as soft tissue tumors (STTs) originate from non-epithelial (mostly mesenchymal) tissues that are not part of the skeleton, such as blood vessels, peripheral nerves, muscle, tendons, fat, and fibers (ligament, fascia). Reports say that there are 300 benign STTs per 100,000 people per year, which is a lot more than the number of malignant STTs.¹ Only around 1 percent of tumors are soft tissue sarcomas

(STS), making them comparatively uncommon.^{2,3} In contrast to benign tumors, which merely need to be monitored and occasionally surgically removed, malignant tumors necessitate surgery along with other therapies such chemotherapy, targeted therapy, and radiotherapy. It is crucial to classify STS as benign or malignant because delayed discovery has a detrimental impact on patients' survival prognosis and treatment outcome.⁴

Magnetic resonance imaging (MRI), computed tomography, positron emission tomography, ultrasound, and X-ray are among the imaging methods commonly used to evaluate soft tissue tumors. Because of its broad range of applications, high sensitivity, nonionizing radiation, and affordability, ultrasound (US) is the first test used to evaluate soft tissue masses.⁴ US can easily differentiate between solid and cystic lesions and offer information on the size and anatomical location of the lesions.⁵ Additionally, US can show the hemodynamic alterations within the lesions by using color Doppler. MRI is regarded as the preferred first test for locating, characterizing, and staging large, deep lesions. Its strong intrinsic contrast resolution makes it ideal for determining the anatomic extent of STTs and evaluating local staging.⁵ MRI makes it possible to identify the tumor's anatomy, characterize the lesion based on its signal characteristics, and assess the tumor's precise size and connection to the surrounding structures. MRI also aids in surgery planning and post-treatment follow-up. It is quite challenging to make a reliable histological diagnosis of STTs, nevertheless. Only roughly half of cases could be accurately predicted by MRI for diagnostic histology, according to a research by Gielen et al.⁶

The imaging characteristics of soft tissue tumors on MRI and the associations between individual or combination tumor characteristics, have been the subject of several research worldwide.⁷⁻⁹ These research' findings, however, are not entirely consistent. Consequently, we conducted this investigation to assess the function of magnetic resonance in the differentiation of benign and malignant soft tissue tumors.

METHODOLOGY:

Total 80 patients who presented with suspected soft tissue cancer (soft tissue swelling accompanied by fever, malaise, or body aches lasting longer than two weeks) at the Department of Radiology, Fauji Foundation Hospital, Rawalpindi, between May 2025 and October 2025 were included in this cross-sectional validation study. The 95% confidence level, 48.15% prevalence, 10% absolute precision, 89.2% sensitivity, and 88.5% specificity were used to determine the sample size.⁸ Patients taking chemotherapy for any type of lesions, liver cirrhosis, undergone orthopedic surgery, claustrophobic patients and with cardiac pacemakers were excluded.

Prior to biopsy or surgery, all patients had routine MRIs on 1.5 Tesla or 3.0 Tesla machines to look for STTs. The MRI was performed using a 1.5 Tesla magnetic resonance equipment. Regular MRI scans in at least two planes (axial, coronal, and sagittal) were performed on the patients. Every MRI included a minimum of one fat-saturated or short tau inversion recovery (STIR) sequence, one T1-weighted (T1W), and one T2-weighted (T2W). The thickness of the slices varied from 3 to 5 mm. After that, an intravenous injection of gadolinium contrast was given, and then a T1W sequence was done in at least one plane.

The qualitative imaging characteristics of soft tissue tumors (STTs) included bone involvement, vascular involvement, post-contrast enhancement. They also included hyperintensity on T1-weighted images and hypointensity on T2-weighted images. Tumor margins can be either lobulated or non-lobulated. The tumors' borders may be clearly defined or not. Peritumoral edema was defined as a fat-saturated region surrounding the tumors and an infiltrated, hyperintense T2W. The presence of bone marrow edema or cortical erosion next to the tumor indicated bone involvement. If the tumor was eroding into the blood artery or in touch with it at an angle greater than 180 degrees, vascular involvement was deemed to be present. After that, each patient had a biopsy, and the results of the histopathology report—which states that the presence of hyperplastic blood vessels and tiny patches of necrotizing tissue encircled by anaplastic cells will be considered a positive result for malignant tumors—were compared to the MRI results.

The data that was collected was analyzed using SPSS version 25.0. The mean and SD or median (IQR) were calculated for age and symptom duration. The frequency and percentage were calculated using the following factors: gender, soft tissue cancer on MRI, and histology (present or absent). Using histopathology as the gold standard, the sen, spec, NPV, PPV, and diagnostic accuracy of MRI in identifying soft tissue cancer were calculated using a 2x2 contingency table. Stratifications and post-stratification were used to control for effect modifiers such mass size, age, gender, and the length of symptoms. A 2x2 contingency table was used to calculate the diagnostic accuracy.

Table: 1

		Soft tissue carcinoma on histopathology	
		Yes	No
Soft tissue carcinoma on MRI	Yes	TP	FP
	No	FN	TN

RESULTS

With a mean age of 48.77 ± 10.02 years, the study's participants ranged in age from 20 to 60. Table I shows that 46 patients, or 57.50% of the total, were between the ages of 41 and 60. The male to female ratio of these 80 patients was 1.5:1, with 52 (65.0%) being male and 28 (45.0%) being female. The average duration of the disease was 6.97 ± 3.15 weeks. The distribution of patients with various factors is shown in Table I.

41 patients (True Positive) had soft tissue cancer out of those who tested positive for it on MRI, whereas 07 patients (False Positive) had no soft tissue carcinoma according to histopathological results. Table II shows

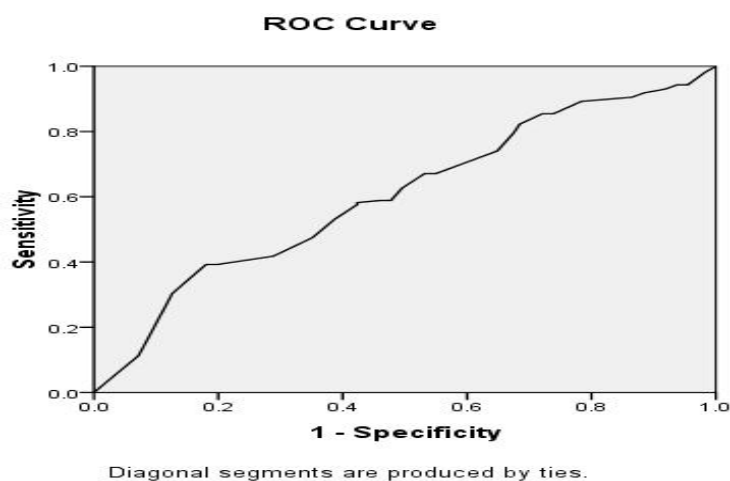
that of the 32 patients who had negative MRI results, 4 (False Negative) developed soft tissue cancer on histology, while 28 (True Negative) did not ($p=0.0001$). Soft tissue cancer was diagnosed with MRI sensitivity of 91.11%, specificity of 80.0%, PPV of 85.42 %, NPV

of 87.50%, and diagnostic accuracy of 86.25%. The diagnosis accuracy stratification by age, gender, and symptom duration is shown in Table III.

Table I: Descriptive statistics (n=80)

		Frequency	%age
Age (years)	20-40	34	42.50
	41-60	46	57.50
Gender	Male	52	65.0
	Female	28	35.0
Duration of symptoms (weeks)	≤8	41	51.25
	>8	39	48.75

Table-II: Diagnostic accuracy of MRI in detecting soft tissue carcinoma, taking histopathology as gold standard.



	Histopathology findings (+ive)	Histopathology findings (-ive)	P-value
MRI (+ive)	41 (True positive)	07 (False Positive)	0.0001
MRI (-ive)	04 (False negative)	28 (True Negative)	

Sensitivity: 91.11%
Specificity: 80.0%
Positive Predictive Value (PPV): 85.42%
Negative Predictive Value (NPV): 87.50%
Diagnostic Accuracy: 86.25%

Area under the curve = 0.605

Table III: Stratification of diagnostic accuracy with respect to age, gender and duration of symptoms.

		Sensitivity	Specificity	PPV	NPV	DA	
Age (years)	20-40	90.23%	82.35%	87.47%	89.34%	88.46%	0.001
	41-60	92.76%	80.24%	84.89%	86.54%	85.89%	0.001
Gender	Male	91.84%	82.78%	86.72%	87.50%	87.29%	0.001
	Female	91.78%	83.78%	85.67%	88.65%	86.46%	0.001
Duration (weeks)	≤8	92.91%	83.42%	86.52%	89.16%	90.99%	0.001
	>8	91.27%	80.17%	86.98%	87.35%	87.68%	0.001

DISCUSSION

A biopsy is typically the final step in a diagnostic procedure that assesses the histological characteristics, anatomical extent, and features of soft-tissue sarcomas and bone malignancies.¹⁰ Magnetic resonance imaging (MRI), on the other hand, is widely considered the most effective imaging modality for assessing soft-tissue masses and ascertaining the degree of bone marrow or soft-tissue involvement in bone malignancies.^{10,11} MRI provides detailed information about tumor size, local spread, and depth. Divergent opinions on how well MRI can differentiate between benign and malignant lesions and characterize the pathogenic nature of musculoskeletal tumors may be found in the literature. Additionally, the stated specificity ratings for MRI in detecting soft tissue cancer vary widely.⁶

This study primarily investigated the diagnostic performance of MRI in detecting soft tissue cancer. In the diagnosis of soft tissue cancer, the study found that MRI sensitivity was 91.11%, specificity was 80.0%, PPV was 85.42 percent, NPV was 87.50%, and diagnostic accuracy was 86.25 percent. Our findings are consistent with previous research, demonstrating the usefulness of MRI not only for cancer detection but also for managing patients with musculoskeletal malignancies and helping with treatment planning. ALI S et al.⁸ evaluated this study and found that MRI had diagnostic accuracy of 88.89%, sensitivity of 89.23%, specificity of 88.57%, PPV of 87.88%, NPV of 89.86%, and sensitivity of 89.23%, while histology was the gold standard for identifying musculoskeletal cancers.

But according to a another study that looked at MR mammography's diagnostic performance for malignant breast lesions, the sensitivity was higher at 93.9%, while the specificity was lower at 73.5%. This modality has an overall diagnostic accuracy of 89.3% with a PPV of 92.3% and a NPV of 78.1%. These results imply that MR mammography has a different diagnostic reliability profile than musculoskeletal MRI, despite the fact that it can be useful in identifying breast abnormalities.¹²

Additionally, Shirin M et al.¹³ shown that the MRI

showed a 91.4% overall diagnostic accuracy, 96.4% sensitivity, and 71.4% specificity in detecting malignant musculoskeletal tumors. In a different study, Boruah DK et al.¹² assessed how well diffusion-weighted imaging worked in conjunction with conventional MRI sequences to distinguish between benign and malignant musculoskeletal diseases. According to their findings, this approach exhibited an 83.3% sensitivity and an 87.5% specificity. The diagnostic approach was effective in diagnosing soft tissue cancer, as evidenced by its overall accuracy of 84.6%.¹⁴

In a study¹⁵, of the 110 individuals (59 males and 51 women), 44 had malignant tumors and 66 had benign ones. Hypointensity on T1-weighted images and hypointensity on T2-weighted images were the most important qualitative factors that helped tell the difference between benign and malignant STTs. Multivariate linear regression analysis showed that peritumoral edema and heterogeneous enhancement were the best ways to tell the difference between malignant and benign tumors.¹⁵ The overall diagnosis accuracy of 92.8% for MRI showed its value in this clinical context.¹³ Our findings were corroborated by a few other studies.^{16,17}

A different study also showed that, in comparison to histopathology, MRI has a high diagnostic accuracy of 88.97%.¹⁸ The successful diagnostic outcomes demonstrate how important it is to use MRI in regular clinical practice to evaluate these difficult situations. The specific MRI features that contribute to this accuracy as well as the connection between these imaging findings and prognosis require more investigation.

Notwithstanding compelling results, a number of restrictions must be noted. First, the study's generalizability may be limited because it was only carried out at one tertiary care facility. Second, only recently diagnosed cases were included; post-surgical instances and recurrent tumors, where fibrosis or scarring can make MRI interpretation more difficult, were not included. Third, although all images were

interpreted by a senior radiologist, interobserver variability was not evaluated, and external validity would be strengthened if additional readers were included. Lastly, sophisticated imaging sequences that would have increased specificity, such as DWI and perfusion MRI, were not used. Overall, our research supports MRI's use as the main non-invasive modality prior to biopsy by providing region-specific evidence of its excellent diagnostic accuracy for musculoskeletal malignancies. MRI can improve surgical planning, minimize patient morbidity, and expedite the diagnostic process by lowering diagnostic uncertainty and directing focused tissue collection. To further hone its clinical role, multicenter research involving advanced functional MRI measures and evaluation of prognostic implications are necessary. 19,20

CONCLUSION:

A study found that MRI scans are very accurate in diagnosing soft tissue masses, especially when it comes to diagnose soft tissue cancer. This level of accuracy can significantly lessen the need for invasive histopathological methods, which speeds up the diagnostic process and reduces patient risk and discomfort. More thorough studies aimed at enhancing the reliability of this diagnostic tool would empower healthcare providers to make better decisions on patient care, ultimately leading to better overall care and efficiency.

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